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EDITORIAL

Role of dual PET/CT scanning in abdominal malignancies

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Modern cross-sectional structural imaging techniques like ultrasonography, computed tomography (CT) and magnetic resonance imaging (MRI) provide high resolution images that aid in accurate detection, delineation and anatomic localization of abdominal malignancies. However, characterization of lesions into benign and malignant abdominal etiologies is often not possible from structural imaging techniques alone. Although functional imaging techniques like positron emission tomography (PET) with radiolabeled ^{18}F labeled 2-fluoro-2-deoxy-D-glucose (^{18}F-FDG) often provide critical information pertaining to a benign or malignant etiology, accurate anatomic localization of abnormal regions of uptake is often problematic due to inadequate spatial resolution. These circumstances make the combination of PET with CT appealing. It has the potential of offering a comprehensive 'one-stop' examination by providing information about lesion etiology based on functional activity on PET scanning along with precise anatomic localization and other morphological features of the abnormality with CT scanning[1–3].

Attempts at combining PET and CT data from different machines with software image fusion are facilitated by extracorporeal (fiducial) points and line markers fixed on the patient's skin in the same position for each imaging study. This software fusion permits evaluation of two modalities in one integrated image dataset but results in less satisfactory fusion due to differences in patient positioning and involuntary movement of abdominal organs between scans[4,5]. Although true hardware fusion of PET and multidetector CT does not exist, more precise projection of the PET image over the CT image can be obtained with the currently available hybrid PET/CT scanners, which consist of separate scanners that are positioned in line at a fixed distance within a single gantry assembly[6]. The CT images are used for more precise and rapid attenuation correction of the PET data and as anatomic reference of the radiotracer uptake patterns evaluated with PET. They also provide some valuable information regarding morphological features and attenuation values of lesions. In addition to reducing the PET imaging time per patient from 45 to 60 min with a conventional dedicated PET scanner to 15–30 min, the hybrid PET/CT scanners also reduce the number of equivocal PET interpretations.

The introduction of CT-based attenuation correction and its integration with PET necessitates different PET/CT scanning protocols. In general, the two approaches adopted for PET/CT scanning are using the CT to perform faster attenuation correction with little emphasis on anatomic co-registration or using the CT not just for attenuation correction but for diagnosis and co-registration as well[7]. Whereas the initial approach mandates that the CT be performed with the lowest permissible radiation dose without affecting attenuation correction, in the latter approach CT is performed with standard radiation dose to attain diagnostic image quality. Regardless of the approach, prior to PET scanning, CT images are acquired to optimize patient positioning and perform attenuation correction for PET images. Although recent studies have shown that oral and intravenous contrast media can be administered for the diagnostic CT to aid lesion localization and support characterization, modifications are necessary to

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avoid image artifacts in the PET images and ensure appropriate attenuation correction[8–10]. Artifacts may also occur due to beam hardening artifacts from metallic orthopedic and dental implants, which affect CT-based attenuation correction of PET images[11–13]. In addition, mismatch of internal organs due to breathing movements and inconsistent patient positioning must be minimized so as to facilitate precise PET/CT co-registration in abdominal studies[14,15]. Normal 'free' breathing or normal expiratory phase for acquisition of CT images has been found to be more suitable than maximum inspiratory or maximum expiratory phases.

In general, the hybrid PET/CT scanner offers many possible advantages for improved patient care. These include improving the diagnosis and staging of abdominal cancers, aiding in the identification and localization of disseminated malignancy, differentiating recurrent disease from post-surgical inflammatory change, improving surgical and radiation therapy planning, and monitoring the response of chemotherapy and radiation therapy[16,17]. An initial study has reported improvement in staging of abdominal-pelvic cancers to 89% with PET/CT compared to 78% with PET alone[18]. A significant improvement in anatomic localization and a decrease in the number of equivocal findings have been reported in patients with abdominal-pelvic malignancies undergoing PET/CT scanning[18]. In addition, a recent study has reported that PET/CT is more accurate than PET or CT performed separately and can affect management in 22% of patients with esophageal cancer by helping both in cancer staging and the evaluation of post-surgical or post-chemotherapy recurrent/residual tumor[19]. Although data supporting its use in pancreatic and gastric cancer are lacking, PET/CT may help in the accurate characterization of PET equivocal lesions into benign or malignant etiologies, in guiding biopsies to the metabolically active tumor and in detection of metastatic lesions[20]. Likewise, PET/CT is likely to improve detection and localization of peritoneal metastatic implants from various abdominal malignancies that can help in the planning of guided biopsy or surgical resection. Compared to PET scanning alone, PET/CT can aid in more accurate detection and staging of recurrent colorectal cancer following surgical resection or radiation therapy as well as improve the sensitivity and specificity for detection of metastases[21,22]. A recent study in 16 patients has reported that in spite of the high sensitivity of PET/CT for detecting metastatic liver cancers, a negative PET/CT does not preclude the presence of primary liver cancers due to its low sensitivity in this group[23]. Schoder *et al.* have observed that PET/CT scanning contributes critical information in 30–40% of patients as compared with PET alone in lymphoma, melanoma and gastrointestinal malignancies[18].

Although the hybrid PET/CT scanner clearly represents an important technologic advance, the alliance of functional imaging with structural imaging has also raised many controversial issues. These include: the exam reimbursement, the degree of superiority of PET/CT over PET alone, the validation of indications for use of CT for diagnosis or transmission source alone, the cost-vs.-benefit analysis of PET/CT imaging in patients with abdominal malignancies, the specific indications and protocols for low radiation dose CT, as well as the suitability and timing of oral and intravenous contrast. In conclusion, while recent publications pertaining to hybrid PET/CT scanners have been encouraging, larger prospective studies will be necessary to establish the optimal hybrid scanning protocols and to determine the precise impact in the evaluation of patients with abdominal malignancies.

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